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PATENT SPECIFICATION

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(21) Application No. 6737/72 (22) Filed 14 Feb 1972
(31) Convention Application No. 7138391 (32) Filed 26 Oct 1971 in (19)
(33) France (FR)
(44) Complete Specification Published 7 Apr 1983
(51) INT. CL.[3] A61F 9/02
G02B 5/28
(52) Index at Acceptance G2J S2B6A S2B7X FI

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(54) PROCESS AND DEVICE FOR PROTECTION AGAINST FLASH BLINDNESS

(71) We, COMMISSARIAT A L'ENERGIE ATOMIQUE, an organisation created in France by ordinance No. 45-2563 of 18th October 1945, of 29 rue de la Federation, Paris 15e, France, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

BACKGROUND OF THE INVENTION

The invention relates to a process and device for protecting the eyes against intense flashes of light emitted by nuclear or thermonuclear detonations while retaining a permanent sight of the environment. The invention is particularly useful for protecting the crew members of aircraft and armoured cars.

The light flashes emitted by nuclear or thermo-nuclear detonations have a spectrum similar to that of a black body which is however truncated for wave lengths lower than 3400 Å, probably due to absorption by the ozone generated by the gamma rays and exhibits a maximum of brightness at about 3800 Å. The most severe damages for retina occur during the second maximum of light since the fire ball then has a large apparent diameter, a high temperature and a long duration.

Two solutions have been used to protect the crew members against flash blindness. Flash blindness protective goggles have been developed which have planar lenses whose optical density is higher than 4 in the complete light spectrum (visible light, infra-red and ultraviolet). But such goggles prevent the wearer from seeing the outside and cannot be used permanently, thereby being useless when there is a permanent risk of nuclear blast, that is under tactical use conditions.

An improved device using photochromic lenses has also been developed. The device comprises a pair of lenses and each lens includes a thin layer of photochromic solution confined between two quartz wedges. The device also comprises a light sensitive detector which takes up early light prior to the minimum and triggers flash tubes which illuminate the photochromic solution with ultra-violet energy, causing it to become opague for about two seconds. Although this constitutes an improvement over the use of glasses having a high optical density, the two-seconds interruption of visibility constitutes a definite drawback, particularly for pilots of supersonic aircraft. In addition, failure of the device to operate results in irreversible retinal burns.

The present invention is based on the discovery by the inventor that the light spectrum from an atmospheric nuclear or thermo-nuclear blast becomes discontinuous from a time which is prior to the minimum of light, that is prior to the time when the light flash may result in particularly dangerous retinal burns. More precisely, narrow bands of intense absorption, probably due to the interaction of the gamma rays with the oxygen nuclei of the atmosphere, appear prior to the minimum and remain present up to the end of the fire ball. It was also found that some of the absorption bands are in coincidence with the emission peaks of corresponding metal vapour lamps, whereby a satisfactory vision of the environment may be maintained by using such lamps if solar light is available. One of the absorption bands is substantially centered on the two yellow lines in the spectrum at 5890 Å and 5896 Å radiated by sodium vapour lamps, that is in a zone of the spectrum for which there is a near maximum of the sensitivity of the eye. Another absorption band is narrower and corresponds substantially to the green line of cadmium at 5085 Å. There is still another absorption band in red at 6280 Å and a band in the blue portion but these are of less advantage, because the last named band is in a zone of the light spectrum of the nuclear blast which is particularly energetic and the first named band does not correspond to a line radiated by a currently available metal vapour lamp.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the invention to provide a process and device which efficiently protect against flash blindness without interfering with permanent vision.

It is another object of the invention to provide a process and device which use passive protective components, so that no malfunction can occur.

For this purpose, there is provided a device

for protection against flash blindness from intense flashes of light emitted by nuclear or thermo-nuclear detonations, such device comprising at least one shield for location between the environment and the eyes, the spectral transmission window or windows of said shield being at most of 5 Å and centered at about 5085 Å, 15 Å at about 5895 Å and 5 Å at about 6280 Å, and a light source having a substantial part of its light emission in such windows. The light against which protection is provided has a spectrum with absorption bands within which are included the said spectral transmission window or windows.

BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWING

The invention will be better understood from the following description of embodiments given by way of non-limitative examples and which refer to the accompanying drawing wherein:

Figure 1 represents flash blindness protective goggles; and

Figure 2 represents a cross-sectional view of one of the lenses of the goggles of Figure 1, with the interference filter shown on an enlarged scale.

DESCRIPTION OF A PREFERRED EMBODIMENT

Spectrograph analysis of the light emission from a nuclear or thermo-nuclear blast with a very dispersive apparatus indicates that the spectrum is split by narrow bands in which intense light absorption occurs. In the visible spectrum, a band of maximum width consists of fine and deep absorption lines, is centered at about 5895 Å and has a total spectral width of about 15 Å. That band brackets the two yellow lines D_1 and D_2 of low pressure sodium lamps (at 5890 and 5896 Å). Two other absorption bands, narrower and weaker, are found in the green at 5085 Å and in the red at 6280 Å respectively. Both bands have a width of about 5 Å and the first one brackets a line of cadmium at 5085 Å.

There is also a blue absorption band but in a zone where light emission is particularly intense and which should preferably be left unused for that reason.

Referring to Fig. 1, there are shown goggles 10 which make use of the absorption bands. The goggles 10 have a flexible, continuous, entirely opaque frame adapted to be worn contiguously to the face for sealing of light and two lenses 12. Each lens 12 (Fig. 2) comprises an interference filter of sufficient quality for having a transmission window which is entirely within a wave length band of 15 Å if the window is centered on 5895 Å or 5 Å for the other two windows. An interference filter should be used since for the time being there is no other filter which is adapted to provide a sufficiently narrow transmission window. However any other system providing a narrow and well-defined window adjustable at the proper wave length would be acceptable. For all practical purposes, goggles will generally be used which provide a window of about 10 Å or 3 Å respectively for taking into account possible errors on the central wave length and progressive increase of transmission at the limits. It is possible to make a slight wave length correction by locating the lenses in a direction which is not exactly perpendicular to the direction of light.

Referring to Fig. 2, the interference filter may consist of a series of alternate layers 14, for instance of zinc sulphide and calcium fluoride, prepared by conventional processes; a description of such processes may be found in "Encyclopaedic Dictionary of Physics", Pergamon, 1961. A filter having from 45 to 50 half-wave layers whose thickness is controlled with a precision of about 1/1000 provides satisfactory results in most cases.

Each lens 12 of the goggles also comprises a front glass 16 absorbing UV light, located in front of the interference filter, as shown in Fig. 2 of the drawing. The glass may be a OG 5 Schott glass whose optical density is at least 8 for the wave lengths lower than 5700 Å and which passes the longer wave lengths up to infra-red. A shock-proof polished planar lens 18 is located behind the filter and may be a catathermic glass lens absorbing infra-red rays. Such a protective lens 12, when complete, has a transmission coefficient of about 40% in the mid-portion of the light transmission window.

Several combinations of protection lenses are possible including the following:

– The two lenses may be identical and have the same transmission window. In that case filters will preferably be used which correspond to the yellow absorption band which is the widest, is close to the maximum sensitivity of the eye and corresponds to the lines radiated by the sodium vapour lamps which are already in general use. The window width may be about 10 Å to compensate for slight errors in centering the transmission window on the absorption band. Under such conditions the light energy received from the fire-ball remains low in spite of the relative width of the absorption band since the flash has a relatively low luminescence in the central portion of the band.

For particular uses however, it may be advisable to use goggles having filters providing a green window, on the other side of the 5500 Å wave length which corresponds to the maximum sensitivity of the eye. This is particularly true when a lamp is used which provides a maximum of light in that zone.

– The two lenses may be identical and each have two separate transmission windows in order to provide two-colour vision. This result may be obtained by including in each lens two interference filters which are successively traversed by incident light. Each filter has several transmission bands which partially overlap and the overlapping zones are selected to correspond to two absorption bands in the

emission spectrum.

Since such lenses are most difficult to build, a solution providing less satisfactory results, but still providing dichromatic vision, consists in using two different lenses one of which has a window centered at 5895 Å and the other of which corresponds to another absorption band (red or green).

– For approximative trichromatic vision, the goggles may include a first lens having a single window (yellow absorption band for instance) and a second lens associated with the other two windows (red and green).

When the surroundings are lighted by the sun, a satisfactory viewing of the environment through the goggles or through an optical shield including a similar interference filter is obtained since the emission spectrum of the sun has no absorption band corresponding to those of a nuclear blast. At night or in a vehicle or aircraft, a source of light compatible with the transmission windows of the goggles will on the contrary be necessary. If the filters have a transmission band centered at 5895 Å, use may be made of a low pressure sodium spectral lamp since most of its light is emitted at 5890 Å. If the filters are centered on 5085 Å, use may be made of a cadmium spectral lamp which emits part of its light flux at 5085 Å. Since a number of airport runways and highways are lighted by low pressure sodium spectral lamps, it may be noted that goggles with a yellow passing window do not adversely affect the ability of a pilot or driver to see under those conditions which render maximum visual accuracy of particular importance, although optical densities of 4 and 6 at least are achieved as a rule for wave lengths higher and lower than the passing window, respectively.

In the aircraft or cars where no 110 V or 220 V A.C. electrical current is available for energizing metal vapour spectral lamps, use may be made of a quartz-iodine lamp for lighting the dials of the control panel. Such a lamp provides a light spectrum which overlaps the transmission windows. UV lamps may also be used for excitation of fluorescent material carried by the dials and which re-emits light in the transmission band or bands of the lenses or shield. In all cases a source of white light may be used, but with substantial loss of brightness.

Rather than planar, the lenses may be in the form of part-spherical caps, with parallel surfaces and with a radius selected for the sphere to be centered on the pupil of the eye. A substantial increase of the field of view may be obtained in this way but the construction of such part-spherical lenses is rather difficult.

WHAT WE CLAIM IS:

1. A process enabling simultaneous viewing of the environment and of a temporary light source having an intensity sufficient to damage the retina, said source emitting a light spectrum which has at least one narrow and intense absorption band in the visible portion of the light spectrum, comprising: locating between the source and the eye an absorbing shield which has a precisely limited light transmission window or windows, each included within one said absorption band; and lighting the environment with light having a substantial portion of its energy in said window or windows.

2. A process according to claim 1 for protecting the eyes against intense flashes of light emitted by nuclear or thermo-nuclear detonations, wherein said shield is given a transmission window centered at about 5085 Å, 5895 Å or 6280 Å and having a spectral width of 5 Å, 15 Å or 5 Å respectively at most.

3. A process according to claim 2, wherein the environment is lighted with a low pressure sodium spectral lamp or cadmium spectral lamp.

4. A device for protection against flash blindness from intense flashes of light emitted by nuclear or thermo-nuclear detonations, such device comprising at least one shield for location between the environment and the eyes, the spectral transmission window or windows of said shield being one at most of 5 Å and centered at about 5085 Å, 15 Å at about 5895 Å and 5 Å at about 6280 Å, and a light source having a substantial part of its light emission in such windows.

5. A device according to claim 4, wherein the shield includes an interference filter.

6. A device according to claim 5, wherein the interference filter is planar.

7. A device according to claim 4, 5 or 6 wherein the light source is a sodium or cadmium spectral lamp or a quartz-iodine lamp.

8. Protection goggles having two lenses, each lens having an interference filter whose spectrum transmission window is entirely within one of the intense absorption bands of the emission spectrum of the fireball resulting from a nuclear or thermo-nuclear detonation.

9. Goggles according to claim 8, wherein the interference filter is planar and is at a slight angle with the axis of the field of view, said angle being selected for the transmission window to be centered within said absorption band.

10. Goggles according to claim 8 or 9, wherein the interference filter has the shape of a part-spherical cap.

11. Goggles according to claim 8, for dichromatic vision, in which two separate transmission windows are each provided by a separate one of the lenses or are each provided by both lenses which each comprise two interference filters successively traversed by the light and having overlapping transmission bands.

12. Goggles according to claim 8, 9, 10 or 11, in which each lens comprises an ultra-violet absorbing glass in front of the interference filter and a support glass behind the filter.

13. Goggles according to claim 12, wherein the support glass is a catathermic glass.

14. Goggles according to claim 8 providing three transmission windows for trichromatic vision.

15. Device for protection against flash blindness substantially as described with reference to the accompanying drawing.

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Printed for Her Majesty's Stationery Office by MULTIPLEX medway ltd., Maidstone, Kent, ME14 1JS. 1983. Published at the Patent Office, 25 Southampton Buildings, London WC2 1AY, from which copies may be obtained.

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1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

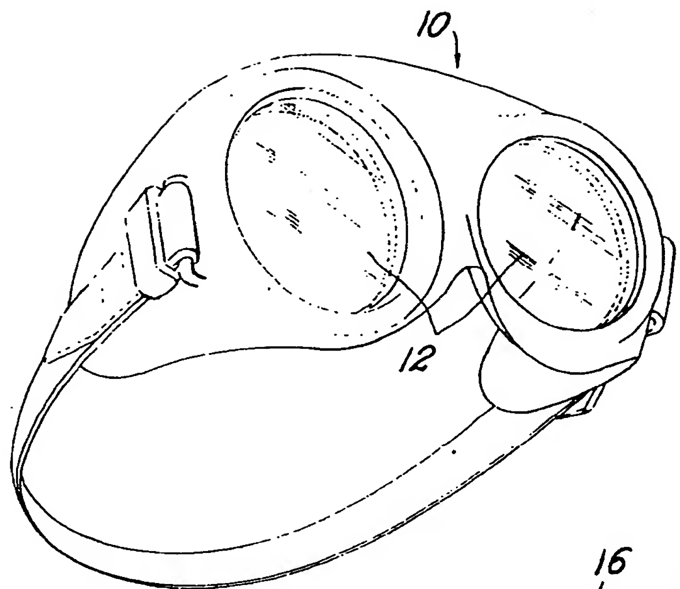

FIG.1

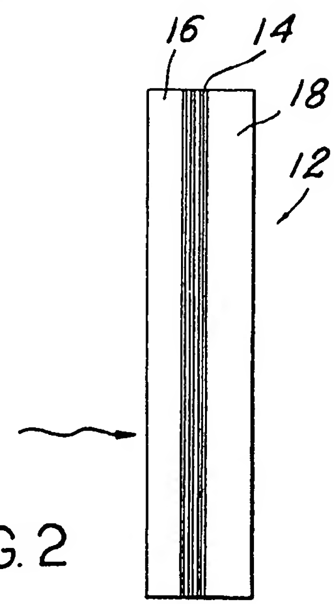

FIG. 2

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